Comments on Draft Groundwater Source Control Final Design Report
NW Natural GASCO Site, Portland, Oregon
Dated May 2011

Submitted June 29, 2011

The following are EPA comments on the *Draft Groundwater Source Control Final Design Report* dated May 2011 and prepared by Anchor QEA, LLC (AQ) for NW Natural.

EPA understands that the purpose of the document is to present a one hundred percent design for a complete hydraulic containment system that can be constructed and operated upon approval by the Oregon Department of Environmental Quality (DEQ).

EPA has the following general comments related to this document.

General Comments

1. EPA has several specific comments on sections throughout the draft Final Design Report that relate to the following topics.

    a. Capacity of the extraction wells to pump over the long-term seasonally and as a result of anthropogenic changes to the surface recharge that include site paving and a newly proposed (not in previous design documents) Fill Water Bearing Zone (WBZ) Interceptor Trench.

    b. Meeting the remedial action objective (RAO) of complete prevention of discharge of upland groundwater to the Willamette River.

    The specific comments below point to a need for further evaluation of long-term extraction well production capacity as well as deficiencies in the performance monitoring that, at its current design, presents significant uncertainty in demonstrating hydraulic control of upland groundwater discharge to the Willamette River and prevention of recontamination of riverbank and in-river sediment post cleanup.

2. The document is void of any discussion and analysis of how well specific capacity (determined from the 2010 pumping tests) relates to available drawdown and what average extraction rates and drawdown at these rates are necessary and if they are achievable at each extraction well for long-term hydraulic control of groundwater discharge through the upper and lower alluvium.

3. The modeling presented in the report to support the design needs to incorporate all of the elements of the design. For example, two significant elements are not presented in the simulations, namely 1) the interception

trench in the Fill WBZ and 2) changes in surface characteristics such as paving, which will decrease the recharge to the alluvium water bearing zones.

EPA has the following specific comments related to this document.

Specific Comments

1. Section 2.1.4, pages 9 and 10: NW Natural presents profiles showing the extent of total and dissolved free cyanide, yet there is no substantive discussion about these profiles. Total cyanide concentrations appear very high adjacent to the U.S. Moorings site. More discussion should be presented in the document related to these figures and how this chemical of interest is being addressed in the overall proposed Hydraulic Control and Containment design.

2. Section 3.1.3, page 13, paragraph 1, 5th sentence: There does not appear to be supportive analysis to provide a basis for the assumption that when a well is shut down for maintenance, other adjacent wells will be capable of increasing their pumping rates to maintain capture. To fully support this assumption, NW Natural should evaluate this analytically and using specific capacities, available drawdown, well yields necessary for capture as derived from modeling simulations, and Segment 2 constant-rate and VFD testing. Based on a preliminary review of available drawdown at current conditions, sustainable extraction rates in the upper alluvium wells are greatly limited with no additional capacity to increase pumping rates to support the loss of an adjacent shutdown well.

3. Section 3.2.1.4: Figures showing hydraulic response within the primary water bearing units (Fill, Upper Alluvium, Lower Alluvium above the confining layer and Lower Alluvium below the confining layer) should be presented in groundwater modeled head maps and particle capture maps (both in plan and cross-section view) that illustrate extraction well influence based on long-term, sustainable, pumping rates (derived from pumping test results). These illustrations are an important spatial assessment to provide certainty that hydraulic control via extraction wells can be maintained. Currently, only particle capture is presented in plan view in Figure 3-2 with all of the particles originating in the hydraulically upgradient direction. This one figure does not provide a full evaluation of hydraulic control and capture in each of the three water bearing zones since it is unknown what unit the particles are placed vertically. As a result, it is possible that deeper alluvium flow is not evaluated in this particle track distribution, and may escape capture.

4. Section 3.2.1.4, page 19, paragraph 1, last bullet: Additional figures, as a result of additional modeling runs, as referenced in the bullet, do not appear in the report, or Appendix F where the groundwater modeling

documents are presented. These simulations may be critical to the final design and should be provided for review.

5. Section 3.2.1.4 page 20: Groundwater inflows shown in the table need to be broken out to present the components of flow in the horizontal as well as vertical direction. For instance, NW Natural should present how much flow contribution the Fill has to the Upper Alluvium and the Upper Alluvium to the Lower Alluvium. This will help quantify the amount of flow lost to the alluvium as a result of future site paving and the interceptor trench constructed in the fill WBZ. NW Natural should evaluate these changed conditions using the model and present the results (see General Comment 3).

6. Section 3.2.1.4, page 20: Groundwater inflows shown in the Model Water Inflow table estimate 305 gallons per minute (gpm) of flow for the Upper Alluvium and 650 gpm of flow for the Lower Alluvium above the aquitard, while nothing is estimated for the Lower Alluvium below the aquitard. Given the inflow values, and the 10 extraction wells planned for each of the water bearing units, it would appear that each Upper Alluvium well needs to sustain a pumping rate of 30.5 gpm and each Lower Alluvium Well a rate of 65 gpm to effectively control and capture groundwater discharging to the Willamette River. However, pumping test data presented by NW Natural in their March 2011 Segment 2 Capture Zone Field Test Report suggest that Upper and Lower Alluvium wells will have difficulty meeting and/or sustaining these flow rates over the long-term (Upper Alluvium Well P8-39 shows a long-term sustainable flow rate of 2 gpm and Deeper Alluvium Well P9-92 is estimated by EPA to have a long-term sustainable flow rate of 55 gpm). This presents a discrepancy between the groundwater discharge to be controlled and the total sustainable capacity of the extraction wells based on the pumping tests that should be addressed (see Specific Comment 2 for suggestions on evaluating this issue).

7. Section 3.2.1.4, page 21, paragraph 1 bullets: The numerical model was further modified for the Final Design Report, but there is no discussion or documentation that presents details and results of these modifications. For example:

    a. Model area was extended to include U.S. Mooring site – NW Natural should explain the reason for this and what the results of this extension are to the modeled flow and calibration.

    b. Grid spacing was redefined from 40 x 40 ft to 20 x 20 ft – NW Natural should explain how this refinement impacted calibration and/or simulations.

c. Hydraulic conductivity of the shallow alluvium was modified – NW Natural should present both the previous and newly modified distribution of the hydraulic conductivity assignments spatially on a map.

8. Section 3.2.1.4, page 21, last paragraph: NW Natural states that the model was not modified to reflect the numerous slug test results that indicate the Fill WBZ has an average hydraulic conductivity of less than 1 ft/day. Rather, NW Natural maintained a 10 ft/day assignment to the Fill WBZ in the model. The justification for this is the observation that the model calibrated well using the higher hydraulic conductivity and that a higher hydraulic conductivity assignment is more conservative from the standpoint of determining flow to the proposed interceptor trench and sizing of the pump and treat system. However, EPA believes a sensitivity analysis is needed to assess the degree of influence the lower hydraulic conductivity will have to the extraction system design. Since model simulations will be used to evaluate capture of groundwater at assigned flow rates, the extraction wells currently may show higher than actual pumping capacities as a result of higher recharge assigned in the model. NW Natural should re-run model simulations at hydraulic conductivities determined from site data and with the additional design elements (interceptor trench, paving, etc.) to re-evaluate extraction well placement, capacity limitations, and overall design.

9. Section 3.2.1.4, page 22, last paragraph: Transient model simulations using river stage data and results from the variable rate pumping tests conducted in April 2011 to determine long-term pumping rates necessary for tidal and stage changes has not been completed (see last paragraph in Section 3.2.1.4). This analysis and its results could impact the final design and therefore should be provided for agency review before approval of the draft final design report.

10. Section 3.2.1.5: The presentation of groundwater flow vectors in Figures 3-3a continue to be difficult to visualize. These flow vectors should be presented in a more conventional approach, where a vector at the center of each finite difference cell is presented based on surrounding water levels showing the direction and magnitude of flow.

11. Section 3.2.1.9: EPA provided comments to NW Natural concerning the results summarized in the March 2011 *Segment 2 Capture Zone Field Test Report*. The comments noted issues with the assessment of capture over long-term seasonal changes and whether or not some portion of groundwater gradient reversal was being incorrectly assigned to extraction well capture. EPA is now in receipt of NW Natural's response to these comments and will provide a separate comment set related to the NW Natural's responsiveness and any additional

analysis presented in *NW Natural's May 2011 Segment 2 Field Tests of the Programmable Logic Control and Variable Frequency Driver Well Pumps* report.

12. Section 3.2.1.9, pages 25-26, last paragraph: It is unclear what evidence NW Natural has to support the qualifier "short-term" in the last sentence and therefore this text should be deleted. This qualifier implies long-term (duration undefined) extraction in the alluvium wells will eventually capture water in the Fill, which has not been demonstrated in 72-hr test data from extraction well PW-7, PW-8, and PW-9. More likely, extraction under long-term, steady-state conditions will reach a recharge boundary from the River (seen in the PW-3 testing and evaluated in the April 28, 2008 *NW Natural Gasco, Pump Test Analysis and MODFLOW Model Summary*) that will dampen any influence the alluvium wells will have on the Fill WBZ over the long-term. This is significant, because it points to the immediate need to control discharge in the Fill WBZ, where most of the contaminated water exists, rather than rely on some long-term influence that may, or may not occur as a result of alluvium extraction well operation (see specific comment #14 for issues related to delaying control of the Fill WBZ).

13. Section 3.2.2.1: The Fill WBZ Interceptor Trench is a newly proposed design that, from the text provided, does not appear to have been fully evaluated regarding the groundwater flow it will intercept. NW Natural should:

    a. Provide the full analysis, including calculations and assumptions for the 20 gpm estimate of flow from the Fill WBZ into the length of the proposed trench. An estimate of the flow, if 10 ft/day is used for hydraulic conductivity (as it currently is in the updated model; see specific comment 8), should be provided.

    b. Provide a basis that the trench location will intercept all fill groundwater discharge. For instance, the layout of the trench appears to assume the groundwater gradient is straight to the river and no groundwater exists within a measurable distance (~25 ft) of the northern property boundary. This assumption may be the result of data gaps than actual site gradient conditions. It appears some water flow in the Fill WBZ could escape capture and flow to the adjacent U.S. Mooring site based on the current design. In fact, during the remedial investigation at U.S. Moorings completed by the USACE, cyanide has been detected several hundred feet into the southern portion of the Moorings facility. Analytical and/or numerical modeling simulations should be prepared to evaluate the potential need to extend the trench footprint.

c. No analysis of how this intercepted fill water, that naturally recharges the Upper Alluvium, will affect the sustainability (available drawdown) of the Upper and Lower Alluvium extraction wells. Analytical and/or numerical modeling simulations should be prepared to evaluate this potential impact.

14. Section 3.2.2.1, page 27, last paragraph: Deferring the interceptor trench construction to the time when in-river sediment and riverbank cleanup occurs presents significant delays in addressing capture of contaminant flux in the Fill WBZ. As noted from the pumping tests (see specific comment 12), the alluvium wells do not influence and capture flow through the Fill WBZ. Thus, delays in the trench design will allow contaminated flow through the Fill WBZ to enter river sediments for an extended period of time while extraction from the alluvium wells occurs. NW Natural points to the observation that flow through the fill is less than 10 percent of the anticipated total flow from the alluvium pump and treat system, but this percentage has not been supported with any analysis (see specific comment 13a). Furthermore, the sequencing of the steps starting with alluvium extraction, then interceptor trench construction/in-river work should be evaluated using the groundwater model to predict any potential issues with construction interferences and sediment recontamination.

15. Section 3.2.2.2.1, page 28, last paragraph, item #4: NW Natural should provide the reference to analysis, or modeling, that supports this statement.

16. Section 3.2.2.2.1, page 29, first paragraph: NW Natural should provide the quantitative data and analysis that supports the proposed placement of the screen intervals. Statements "shallow enough" and "deep enough to allow for sufficient drawdown to attain the pumping rates needed for gradient control" are not quantitative enough for a 100% design level document. Actual quantities of pump and screen settings, average seasonal available drawdown, and anticipated individual well specific capacities should be provided on a table and checked against pumping rates deemed necessary for gradient control.

17. Section 3.2.2.2.1, page 30, first full paragraph: NW Natural should provide the extraction rates assigned to each extraction well in the model that represents this capture. See specific comment 3 for additional analysis/presentation recommendations.

18. Section 3.2.2.2.2, page 31, second paragraph: EPA disagrees with NW Natural's statement that well construction of extraction wells PW-3, PW-7, PW-8 and PW-9 were appropriate. EPA believes the gradation of the 10-20 filter pack includes too small a gradation for the selected

0.035 inch slot size. Although sanding (filter pack entering the screen) was not an issue during development and/or pumping of these wells, the lower end of this sand gradation, may have plugged the screen slots and contributed greatly to the lower efficiency (well losses) seen in these wells.[1] NW Natural should reconsider its pack selection and choose a filter pack gradation that does not reach the size of the screen slots. Furthermore, the screen intervals appear very short and only partially penetrating the water bearing zones to be controlled. This partial penetration further exacerbates well losses and effectiveness of capture. NW Natural should reconsider its well design to reduce well losses as much as possible.

19. Section 3.2.2.5.2, pages 35-37, last paragraph starting on page 36: Capture assessment appears severely limited and simplistic. For instance, the control wells are too close to pumping wells and represent only gradient conditions between extraction wells. This does not appear sufficient to characterize complete hydraulic control of groundwater discharging through the Upper and Lower Alluvium to the Willamette River. NW Natural should include more wells, including offshore piezometers, in the real-time control of pumping rates and assessment of capture.

20. Section 3.2.2.5.2, page 37, second full paragraph: It is uncertain when wells instrumented with transducers will be evaluated to verify gradient reversal has occurred in deeper portions of the alluvium water bearing zones as measured by the offshore piezometers and upland wells. If not performed in real-time, it would appear to not meet the intent of the RAO of complete hydraulic capture of groundwater discharge through the site.

21. Section 3.2.2.5.2, page 38, first paragraph (continued from previous page), last sentence: As noted in specific comments 2, 5 and 6, NW Natural should evaluate available drawdown and individual well specific capacities based on the available well test data to support the assumption that higher pump rates in extraction wells are achievable to capture flow in the deep alluvium below the aquitard. At the current design, there is significant uncertainty that control in the Lower Alluvium beneath a relatively continuous aquitard can be achieved with partially penetrating wells in the Lower Alluvium above this aquitard. This uncertainty stems from the following:

    a. A lack of data and analysis (analytical or numerical modeling) to support this assumption.

[1] Based on EPA's analysis of pumping test data, the wells appear to average an efficiency of 20% which is far below a properly designed, constructed and developed well, which typically averages 70 to 80% (see Groundwater and Wells, Driscoll, 1986).

b. The inefficiencies coupled with available drawdown limitations in the existing extraction wells to realistically increase flow rates significantly enough to indirectly capture deeper groundwater discharging beneath an aquitard.

Comments on Appendix J (Fill WBZ Interceptor Trench, Design Report, Drawings and Specifications):

General Comments

1. Based on the design report, the document is to serve as a project design report which provides the "technical and logistical information" for the construction of the interceptor trench. The document and drawings state the basic design concepts and provide good illustrations of the construction details. However, the specifications noted on drawings S9 and S10 imply that: "The interceptor trench and appurtenances are… solely the contractor's responsibility to determine the construction procedures, equipment and sequences, and ensure the completed functionality of the system resulting from construction." This implies that a final design will be prepared that describes the contractor's means and methods. EPA requests the opportunity to review the final design.

Specific Comments

1. Wall Design, Excavation, Page 2 of text: This section states that "the excavation support method considered for the interceptor is a combination of partial open cut, to a limited depth, and a specialized highly viscous fluid, a Bio-Polymer." However, no details are provided for this excavation sequence and, as noted in the general comments, it is implied that a final design will be prepared that describes the contractor's means and methods. EPA requests the opportunity to review the final design.

2. Drawing S10 – Products: There are no specifications listed for the Bio-Polymer slurry and slurry enzyme breaker. If these materials are to be provided by the contractor it should be stated as such, with some performance requirements.

3. Drawing S9 and Drawing S10 – Quality Control: The quality control requirements noted are very minimal. A more formal specification should be provided in the final design.